

HOW TO ALLOW FOR USER-CENTERED INNOVATION OVER AN ESTABLISHED INFORMATION INFRASTRUCTURE WITHIN AN INSTITUTIONALIZED CONTEXT

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Abstract

This paper describes a user-centered innovation process within psychiatric services for children and adolescents, implementing a new decentralized model in rural areas in Norway by using mobile phone technology. We apply theory of information infrastructures as a frame of reference for analysing what enables or constrain user-centered innovation processes within a complex organizational context. We illustrates what roles the various levels of an information infrastructure and its installed base can play in innovation processes, implying a complex interplay between technical, organizational and institutional factors. We argue that as a result of this user-centered innovation, the new model emerged with a larger potential for creating a new innovation path than would have been the case if it had been linked to the existing structures. The aim of this paper is thus to contribute to the understanding of how to allow for user-centered innovation over an established information infrastructure within an institutionalized context.

Keywords: Infrastructures, installed base, user-centered innovation, health care

Introduction

Like many other innovations, innovation in the health sector is based on a technological perspective. From a technological perspective, the idea is that ICT will solve many of the major challenges facing the health sector by making it more efficient and citizen-oriented (Blix et al., 2012). Such a perspective often seems to be an expert-driven, top-down development, where neither citizens nor healthcare professionals are involved to any significant extent. In this context it is important to emphasize that health care is not primarily a question of technology. Decisive factors for achieving better health care is working closely with health professionals and collaboration between health professionals and patients. This study focuses on the interplay between mobile technologies, information infrastructures and innovative processes involving the users in the development processes. The development of a mobile communication solution is highlighted as an important part of introducing a new treatment model in distributed, local health care provision. Through user-centered innovation, a new treatment model designed according to a variant of Parent Management Training – Oregon (PMT-O)⁹ was implemented. By focusing on information infrastructure and innovation processes involving the users as active participants, this article describes the interplay between installed base and the innovation processes. The study highlight how an installed base either may enable or constrain the innovation processes, illustrating the inter-relationship between technical solutions, the organizational and institutional, legal

⁹ PMTO is a treatment and prevention program for families with children with antisocial behaviour.

components, users and their uses. Two perspectives that are especially relevant for this article are:

- i)How to explain to what extent a potential for user innovation exist within an existing information infrastructure and its installed base;
- ii)How to explain the dynamic of change by using the concepts of path creation and path dependencies (Garud and Karnøe, 2001) and Zittrain's (2006) concept of generativity.

Based on this the central research question in this article is:

How to allow for user-centered innovation over an established information infrastructure within an institutionalized context?

More specifically, this study show how various elements in an infrastructure influence user-centered innovation.

Structure of the paper

This article is structured as follows: first, a presentation of the theoretical basis (section 2), and thereafter, a presentation of the case in section 3. Section 4 present the method and empirical basis, while analysis and discussion of the findings are presented in section 5, followed by a summary of the article.

Theory

This article combines the theoretical perspective of information infrastructure, user innovation, path creation and generativity. Literature of information infrastructure (II) is used in understanding II to include technological, organizational, institutional and legal elements (Hanseth and Monteiro 1996; Star and Ruhleder, 1996; Hanseth, 2002; Ciborra et al. 2000; Hanseth and Lyytinen, 2010). Innovation is fundamentally tied to social practice (Tuomi, 2002), and in the existing literature on infrastructure (Star and Ruhleder, 1996; Hanseth and Monteiro, 1998; Hanseth, 2000) and user-centered innovation (Von Hippel, 1988, 2005), this perspective is generally deemed to be problematic. According to Bygstad (2010) there is a need for more research on “the causal structure of innovation in information infrastructures, and how this is linked to the growth of the installed base” (p.4). In the next four sections we will present in detail the key concepts.

Information infrastructures

Information infrastructures are described as heterogeneous collections of components (Hanseth and Monteiro, 1996). Hanseth and Lyytinen (2010) present a more precise definition of II “*as a shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities*” (p.4). II is described as heterogeneous, by including several different types of components; both technical and non-technical, including people and organizations, and socio-cultural components (Hanseth and Monteiro, 1998; Hanseth, 2002). Based on this the installed base can be described as a heterogeneous «network» of technical and social-technical components, including network nodes: equipment and software, protocols, standards etc., but also procedures, routines, work practices, knowledge, competence, experience etc. Thus, organizational and institutional structures are also important parts of the installed base. According to Ciborra et al., (2000), cannot an existing installed base be eliminated or replaced and Hanseth (2000), point out that it have a significant impact on how the new one will be designed. Hanseth (2000) claim that new information infrastructures are designed and developed over time as expansions or extensions, along with improvements, of the existing infrastructures, they are never developed from scratch (p.60). Unintended and undesirable effects that are difficult to

anticipate make the building of infrastructures by using traditional strategy complicated. Several empirical studies propose applying more step-wise, evolutionary approaches (Ciborra et al., 2000; Hanseth, 2010; Hanseth and Lyttinen, 2010), including drift and cultivating (Hanseth and Aanestad, 2003). According to Hanseth and Aanestad (2003), such gradual, trial-oriented approaches will make it possible to detect such effects before they entail larger consequences.

User-centered innovation

Innovation covers both invention, the process of creating something new and the result this process gets in the market, e.g. an entirely new product, the launch of an existing product in a new market, or using new production methods. The general understanding of innovation is more or less the same, although the definitions differ slightly. A general definition of innovation is: “*the introduction of something new, a new idea, method, or device*”, (Webster dictionary, online¹⁰;) or a similar definition “*the introduction of novelties; the alteration of what is established by the introduction of new elements or forms*” (Oxford English Dictionary, online¹¹). It has long been recognized that the sources of knowledge and innovation are both inside and outside of organizations (von Hippel, 1995). Tuomi (2002) points out that social driver of innovation are important (p.23-25). Tuomi (2002) describe that users have a central role in shaping innovation processes, as they have strong influence on the social side of innovations, modifying and improving the products, helping to shape technology in all its phases (p.4). von Hippel (1988) present the terms «user-centred innovation» and «lead users» in studies on «the democratization of innovation» (von Hippel 2005). The so-called «lead users» with special competence and interest assume an active role themselves in developing technology or work methods for their own use. According to Tuomi (2002), technology exists as technology-in-use in the context of a specific practice, and that the starting point for innovation studies therefore must be on the social practical level (p.21). Innovation can also be regarded as a process in which organizations seldom innovate alone, but rather in collaboration with other enterprises, networks, formal knowledge-generating organizations (research institutes, universities), legal systems and regulatory statutes (Tuomi, 2002). According to Chesbrough (2003), «open innovation» revolves around how one can access others' creativity and knowledge. Van de Ven et al., (1999) describe that innovation often does not consist of sequential actions, but rather of an interplay of several concurrent processes. Von Hippel (1988, 1995, 2005) claim that user-centered innovation entails the users' being active in the development itself («user innovations») or the developers 'having a new understanding of the users' needs through observation and dialogue («lead users»).

Path dependency and path creation

By discussing the concept *path dependence*, David (1985) and Arthur (1989) brought a dynamic systems view to technology innovation studies. According to David (1985) the concept of path dependence can help explaining that history is important in understanding how technological innovations are adopted. However, entrepreneurs are embedded in structures from which they attempt to depart. In contrast to path dependence, Garud and Karnøe (2001, 2003), present *path creation* as a process whereby innovators seek to deviate from existing thinking. Path dependence and path creation thus present different perspectives on innovation processes. Henfridsson et al. (2009) points to the reciprocal nature of path creation and path dependencies that are reflected in actors' ongoing enactment of existing structures. This article seeks to illustrate how path dependency was linked to the existing way

¹⁰http://oxforddictionaries.com/definition/american_english/innovate2013-03-20

¹¹http://public.oed.com/?post_type=page&s=innovation, 2011-06-20

of providing health services through the information infrastructure, while path creation originated through the break with that socio-technical structure and thereby contributing to the development of a new way of providing health services on an alternative technical platform.

Generative technology

The term generativity can be characterized as the ability of an infrastructure to generate or produce new behavior, structure, or output without the direct involvement of the originator of the system. Zittrain (2006) present the principle of "generativity" in technology: the capacity of some technology to allow its users to make new things out of it, things the designer never anticipated. Zittrain (2006) define generativity as a technology's capacity for leverage across a range of tasks, adaptability to a range of different tasks, ease of mastery, and accessibility. (p.1981). This article seeks to discuss how generative technologies can enable or constrain user-centered innovation processes and the properties of such generative technologies can make them highly applicable for users in innovation processes.

The case

This research describes health care services in a rural, sparsely populated area in the north of Norway, which entails a number of challenges, not least in the field of psychiatric care. Health care is not primarily a matter of technology, and close collaboration with health care providers and between health professionals and patients is essential for achieving better health care. The mobilization of patients' own resources, as well as family and community resources can contribute significantly to the healing process (Brennan and Safran, 2003; Ball and Lillis, 2001). In particular, patients should be provided with adequate care and support in order to manage their health problems to the greatest extent possible. The main empirical base in my research is the introduction of a health program in Finnmark¹² where one reorganized from a central to a decentralized treatment model model. The treatment model which was chosen was based on the Parent Management Training-Oregon (PMT-O) model¹³. This is a treatment and prevention program for families with children displaying antisocial behaviour. An important part of this project has been the development and implementation of an appropriate technical solution based on mobile phones, which can help the care providers as well as the patients in their communication and information handling routines supporting the treatment.

Users in this study represented a large, composite group of different individuals in terms of gender, age, competence, experience, geographical origins and culture, etc. This entailed that the "users" were health workers, team members and psychiatric specialists, in addition to parents, adolescents and children. These users contributed in the innovation by choosing the framework which in turn laid the premises for the chosen solution and were furthermore involved in the development and testing of prototypes. The result has been the development of a new technical solution along with organizational changes required to support the implementation of the PMT-O treatment model. In this development project, the author had roles as both researcher and project leader. These double role provided access to a wide range of information, such as documents, meetings, interviews, e-mail, all of which are

¹²Finnmark is the northernmost and largest county in Norway, although with a population of fewer than 73,000 citizens

¹³PMT-O is based on "social interaction learning theory", developed by Patterson and co-workers at Oregon Social Learning Center. PMT-O is a detailed program designed to improve parenting practices and indirectly reduce antisocial behaviour in the children.

the basis for the study. Through the study of a user-centered innovation process, the focus is on how an installed base may enable or constrain the development of an information infrastructure. This gain insight into the generative properties of a technology, and how it influences the innovative processes, in particular the mechanisms of path creation and path dependencies. These experiences can therefore provide us with better understandings of the complexities in developing and maintaining a new infrastructure, and in particular how to succeed in creating an ICT-based architecture for interaction and collaboration in the provision of health services.

Research method

The research method used in this research is case study in the interpretative tradition and within a larger action research project. Use of qualitative research methods are used to understand and explain the social phenomena related to the II and information system innovations. This research approach enabled the author to describe and understand personal meaning, social phenomena and the experiences from people through data collecting methods such as interviews and observations in its natural environments (Thagaard, 2004). By focusing complexity within human understanding according to the development of the situation, Walsham (2002) claim that you may not define the dependent or/and independent variables in the first place. According to Mathiassen (2002), the weakness of practice studies such as case studies, surveys and interviews is that it separates research from practice. An important part in the methodological approach in this study, is the double role where author active participating as project manager, while at the same time having the role as researcher. Based on the active role and strong user involvement, the present research is an action-based approach, and the research can be defined as action research. The action research approach in this project helps to strengthen this link between research and practice. Action research (AR) is characterized by the researcher's participation in order to change or develop the field along with those who are a part of it. Greenwood and Levin (1998, p.75) claim that “*action research aims to solve pertinent problems in a given context through a democratic inquiry where professional researchers collaborate with participants in the effort to seek and enact solutions to problems of major importance to the local*”. However, the action-based approach is complemented with qualitative methods such as case studies, interviews, observations and document analysis, to establish a more complete and solid foundation for producing rigorous research results (Mathiassen, 2002, p.6). According to Mathiassen (2002), action research can be used as the basic form to establish a close relation to practice and to ensure the relevance of the research, supplemented with methods which support systematic collection of data and application of suitable methods of interpretation. In this research use of qualitative methods enabled us to reflect deeper on the experiences from the project and to systematize the insights that were gained during the process.

The empirical material emerges from qualitative data sources such as individual interviews, observations and document reviews (see table 1). Repstad (1998) underlines that a combination of different methods may offer a broader groundwork for data, and thus a more reliable basis for interpretation. The project was traditionally organized; with a steering group, a project group and a reference group. In addition, a technology group was established. In the various groups there were representatives from CYP, mobile teams, families, supplier and the health trust.

Methods	Type of activities				Total
	2006	2007	2008		
Observation (during participation in meetings and user courses)	3 project teams 7 steering groups	7 project teams 3 steering groups 5 contractors 3 user courses	4 project teams 3 steering groups 5 techno groups	23 other meetings	63
Interview	12 CYP representatives (2 questionnaires were used by CYP representatives for the families)	4 user representatives			16
Document analysis	project documents	meeting notes, emails and reports	user-training notes, workshop documentation		> 100

Table 1 Data collection methods used

Documents

Document analysis is one of several qualitative research approaches in the interpretative tradition of IS research (Myers, 1997; Myers and Avison, 2002; Walsham, 1993). Documentary sources in this research were used to provide background information and an understanding of Finnmark Hospital Trust structure, functions, working routines, and background for the reorganization of the children and youth psychiatric services. When analyzing the documents, there were made continuous evaluations and considerations on whether and in what manner the information in the document had relevance to the project, the project issues, the research question, and if and how the information was relevant to the installed base and the II. When reading the documents, the information were divided into two categories:

- *Information that was relevant to the project.*
- *Information that referred to Finnmark Hospital Trust authority as a whole, and was part of a larger regional and national initiative or strategy.*

Information relevant to the project was systematized in relation to the project domain area, but also in terms of information infrastructure and installed base. This included working practices, knowledge, technology, system solutions etc. The information was systematized by distinguishing between different types of decisions that were taken in terms of strategy, technology, design, delimitation, partner strategy and such.

Interviews

Collection of data through interviews appears to have been an appropriate tool in this study. The use of interview as a technique in data collection enabled the role as a researcher to get physically and psychologically close to the users/informants - and vice versa. Such a reflective posture is essential in order to provide the empirical data with an analytical interpretation. Thagaard (2002) points out that it is essential that you are able to see the importance of your own role in the interaction with users/informants, empirical data and theoretical perspective. In addition, perspectives and the theoretical basis in relation to the researcher's education and interests are required (Malterud, 2001, p.484). According to Walsham (1993, p.14) "*case studies provides the main vehicle for research in the interpretive tradition*". In total, 16 interviews with 16 informants were conducted (see table 1). The informants were CYP representatives and user representatives within the county, in hierarchical positions (from operational, administrative or strategic levels), and situated in

different geographical locations. The interviews were informal and unstructured in the sense that the author as a researcher had a small list of a few basic key words (*old and new treatment model, mobile technology, and user-centered*) to guide the interviewing and most of them were conducted by phone. All interviews lasted for 20-40 minutes, and were transcribed afterwards. In order to make sure that the author as a researcher had understood the informant correctly, they would review and verify the notes afterwards. Use of this strategy provided a useful way to avoid misunderstandings. The objective in using interviews was to receive rich and extensive information on how people in the domain area experienced their own situation. The administrative health care workers in the community experienced the use of Sami language and mobile phone as necessary to get the job done. One of them had this reflection:

"We use mobile phones on a daily basis for SMS and other messages, and all of the messages are written in Sami language. I think mobile phones have been used in Sámi areas since the mobile was introduced. It is natural to use it as a tool because of the long distances. A lot of the citizens in the community are spread all over the large community area, in the mountains, in the small villages. Therefore, we must organize for our citizens!"

During the initial interviews, the focus was on understanding the organizational context and the ambulant teams or therapists' daily work practices. The interviews were primarily semi-structured and open-ended. One of the ambulant teams/clinics was particularly interesting as it provided rich descriptions of their participation and collaboration activities. As one user representative/ responder said;

If you have to use technology as a part of the treatment, it has to be easy to use. It has to be a generally and self-explanatory application etc., otherwise it won't be used."

One of the responders in the ambulant team made the following reflections:

"(...) The process of discussing behaviour and linking it to points written down on a form on the mobile phone is more important than the points themselves."

The perspective on interviews is that the information provided to the author as a researcher is *created when it is provided*, depending upon the relationship between the responder and the author as the researcher. The qualitative interviews were conducted like conversations between the author as the researcher and the responder, which were led by the themes about which the researcher required information (Thagaard, 2004). According to Kvale (1997), the analysis of data is a continuous process that starts in the interview situation and continues with the independent review back at the office.

Observing

The aim of using observation techniques was to gain knowledge and obtain data on the interplay between the installed bases and innovation processes. By observing the users as active participants, we want to explore the tension for user-centered innovation and the existing installed base of the II. There were done 3 observations in 2006, 7 observations in 2007 and 4 observations in 2008 during participation in meetings with the project team. In the same period, 7 observations were done in 2006, 3 observations in 2007 and 3 observations in 2008 during participation in meetings with the steering group. 5 observations were done in 2007 of the contractors, and 5 observations in 2008 of the techno groups. In 2008, 3 observations were done during user courses, and there were observed 4 other meetings in 2007 where the ambulant teams and health care workers from different communities participated. In total, there were done 70 observations in meetings and courses. Observation of meetings was very important during the data collection. In action research, the continuous planning, execution and discussion of key observations is central (Tiller, 1999). Following the project activities closely for three years made it possible to study the interplay between

the installed base and innovation processes. Analysis of information from observations enabled the revealing of different aspects of the II. Thagaard (2004) describes how the relationship between the researcher and informant determines the quality of the empirical material. The following is an example from the research notes, describing the use of video conferencing in a meeting where members discussed new technology, interface and changes of platform:

“All team members are sitting at a round table, in a half circle, with the possibility to look at each other and at the video screen. The member at the video screen can see everyone in the room. Materials are spread out all over the table in no particular order. After a formal presentation, reading aloud the project description, followed by a discussion about the aim and strategy, the group starts a lively discussion about mobile phones and computers, and the standards graphical user interface.”

Observations of the interaction between the various user groups were made to clarify the challenges of existing and new working practices, the use and selection of technology solutions to both existing and new. The data material (notes) were systematized in relation to the start, conduct and final phase of the project. The notes contained information about date, time, used time and place of the observations. The notes also contained information concerning who participated in the situation, as well as a description of the behavior in the situation. Breaks in the observations were also recorded. On the basis of this information, users' participation and influence in the innovation process was uncovered. The analysis has been part of the action research process throughout the project. Postholm (2005, p.99) claims that *"the analysis starts as soon as the researcher enters the field of research and continues throughout the research process"*.

Analysis and discussion

We consider the II as heterogeneous, modular and layered, where the user applications and surrounding organizational and legal context are important parts of its installed base. In this study, the development process included technical aspects, usability requirements and organisational elements. The analysis of the innovation processes is done at three levels, as illustrated in table 2 below:

Analytic level	Focus in the analysis	Critical factors/processes
Organizational level: health service provision etc.	Understanding [identifying] the organizational changes processes and reform(s) in the psychiatric health service provisions that have taken place, including changes in work patterns, relations between professionals and the user, and furthermore, institutional and professional interests and conflicts.	Context: Institutional variables Changes in organizations Important (actors) stakeholders and power structures Professional interests and conflicts
The application development and user level	Identifying and understanding all phases in the system development process and how they involved various user groups which had different background/experience and interests in the SU work	System development approach(es) and phases Different actors and roles in System development
Information Infrastructure level	Understanding the specific characteristics of the two (old and new) II and IB, how they influenced the change processes in the technical [and organizational] innovation: More specifically: what made it possible to move from old to new II?	Characteristics of the two II/IB Technical platform, standards, basic functions services, dynamics, type of applications typical users

Table 2: Research framework

The organizational level addresses the organisational and institutional aspects of providing health services. Change processes have taken place in the provision of psychiatric

health service, including changes in professional work, in relations between professionals and users, as well as institutional and professional conflicts. Critical factors are the institutional context, changes in the organization, important actors' stakeholders and power structures etc. The middle application development level addresses the application development and users involved, with a view to understand the different phases in the system development process and how they involved various user groups having different background/experience, roles and interests, and how it was possible to solve the potential conflicts in this work. Other factors may be the different actors, their functions and roles and, finally, conflicting interests. The information infrastructure level addresses the specific characteristics of the existing and the new installed bases, and in particular how it influenced the change process related to the technical and organisational innovations. Furthermore, we have identified the critical factors and processes such as basic function services, types of applications, typical users etc. This user-oriented innovation was thus based on strong socio-technical orientation, which involved the different user groups within all project phases, in line with Jansen and Nielsen (2005). Table 3 present a multi-level framework for understanding how the development and implementation work involved innovations at three levels: technical platform, application and organization, which can be illustrated in the following way:

Model Level	Old regime/technical and organizational model		New regime: technical and organizational model	
	Old organisational structure	Old system development model	New organisational structure	New system development model
Changes in organization and health service provision	Centralized treatment model	Traditional SU Methodology: Top-down, expert driven Organised at NCT (Norwegian Centre for Telemedicine)	PMT-O – decentralized	Local, user-oriented, , incremental and experimental system development Local Project group (techno-group) Local health personnel + users
Development of the applications	Application based on PC & Videoconferences		Application based on Mobile Phone	
Information Infrastructure	II/IB: based on Broadband Norw. Health Network		Mobile telephone network. Establishment of local techno group	

Table 3 Illustration of changes from the old to the new regime/technical and organisational

We claim that user involvement was made possible by the specific character of this decentralised reform process. It was rooted in the local health care organisation and driven by local psychiatric specialists in close cooperation with their clients (the families), and using standard technology. Thus, we claim that different factors were:

- i. the acceptance of the adoption and adaptation of the decentralized treatment model (PMT-O). This included the reconciling potential professional and social conflicts.
- ii. the establishment of a local development organization with a strong focus on user involvement.
- iii. the decision to use the mobile phones and the existing infrastructure, where the users were already part of the installed base, thus to build the application on a technology with which the users were already familiar.
- iv. a development approach based on a user-oriented, bottom-up strategy and implementation in a decentralized environment.

According to Hazeltine and Bull (1999) these experiences conform to similar efforts in technology transfer, using an appropriate technology adapted to the local technical, organisational and cultural context. While the project from the outset was strongly linked to a rather centralised organisation and technical platform, being rather strongly institutionalised,

the break with these structures cleared the way for a decentralised and simple, but appropriate technical and organisation solution.

How can the different elements of an infrastructure influence innovation?

The information infrastructure level focuses on technology, platforms, various networks, and so forth. According to Ciborra et al. (2000), the different parts of an infrastructure will be under the control of various stakeholders. We illustrate this by the fact that both the Norwegian Centre for Integrated Care and Telemedicine (NST) and Northern Norway Regional Health Authority (NNRHA) are influenced by various parts of the infrastructure. The project participants decision moving from the secure Norwegian Health Net (NHN) including different technology equipment, to an open mobile platform, led to creating new paths by innovation on mobile telephone technology. When the project participants decided to create new paths by innovation on mobile telephone technology, this path entailed moving from the secure Norwegian Health Net (NHN) including video conference technology, broadband, laptop PCs, etc., to an open mobile platform. Hanseth (2000) claim that development and change are significantly impacted by the way a new infrastructure is designed. Innovation in the technical level contributed towards the implementation of mobile technology, and an application on mobile phones. Tuomi (2002) claims that innovations emerge and become articulated when they are taken into meaningful use in social practice. This can be defined in the study as the mobile network was in use outside the health service, and the different element in the new technical solution, was developed as simply as possible for the individual user group. Information infrastructures should always be easy and flexible in a way so that it can be shared by many different users, as well as be a resource for the users by making it possible for them to use it as they want, at the same time (Rolland, 2003). The CYP network became an expansion of the mobile phone infrastructure through the rapid building of an installed base through the innovative processes, where various layers and gateways were used. This describes how the new infrastructure was built on the mobile infrastructure. The user groups, by changing the technical platform and work practices, were also able to free themselves of both the technical and organizational frameworks associated with the previously existing platform (NHN). The new installed base in which the users were already integrated thereby became an enabler, since it opened for new generative, technical solutions; it also became easier to integrate add new user groups and to establish a new organizational solutions. This was a stimulant for both a technical and an organizational innovation. This description, illustrates that the role of the installed base corresponds with what Hanseth (2000) and Star and Ruhleder (1996) claim, namely that IIs grow gradually, built/developed on what already exists.

The user application level addresses applications, development groups, suppliers, methodology, and techniques for development, standardization, and so forth. Since the installed base is defined as heterogeneous, the user-centered innovation is linked to both social and technical elements. Use of applications, type of technology, new techniques, iterative development, and so forth, based on the user groups' preferences and decisions were important factors in the implementation. Through organizational changes and development of new applications for the mobile solution, users were given a central role in the user development process. This is in line with von Hippel (1988) description of users in innovation processes. The earlier strategy was based on a top-down approach, controlled by the health enterprise management and experts from NCT, which again entailed that it was of an expert-driven nature. However, in the innovation project, the users' co-determination came as a result of the individual users' efforts and the interaction between the users in the organization. Such bottom-up -perspective on innovation is in line with von Hippel, who claims that a new understanding of the users will also happen with observation and

communication (1988, 2005). According to Tuomi (2002, p. 10) “(...) *if new knowledge has no impact on anyone’s way of doing things – in other words, if it doesn’t make any difference – it is not knowledge. Only when the way things are done change, an innovation emerges (...)*”.

The organizational level focuses on work practices, services, treatment models, decentralized solutions, people, norms, regulations, statutes, political guidelines and responsibilities. Both the individual user and the decisions and actions of the user groups offered the ability to think in new ways, and to accept new thinking in order to create change. According to Tuomi (2002, p.23) users “*develop new uses for existing technological artifacts, at the same time changing both characteristics of these technologies and their own practices*”. According to Tuomi (2002) users are central in the social practices, and von Hippel (1988) argues that users are both linked to the organization's environment as well as to important sources of innovation. Use of generative theory shows that user-integrated and iterative development gained widespread acceptance because the users during participatory design were able to design the product and service they desired. This was because the technology was conducive and open to user-centered innovation, and the analysis illustrates that technology seem to have characteristics traits in common with generative technology, since these enable innovation. The focus on users corresponds with von Hippel (2001, p.256), who focuses on the fact that the users often design solutions themselves. Von Hippel (2005, p 21) claims “that the user’s ability to innovate is improving radically and rapidly as a result of the steadily improving quality of computer software and hardware, improved access to easy-to-use tools and components for innovation, and access to steadily richer innovation commons”. And further, this concept illustrates the term ‘user-centred innovation’ and ‘lead users’ in the democratization of innovation (Von Hippel, 2005). Strong user co-determination in the development of the new mobile solution facilitated the new treatment model becoming a part of the installed base. Star and Ruhleder (1996, p.113) claim that any information infrastructures is embedded in a wider social context and has “links with conventions of practice”. This was not a new II, as a mobile network which was used as a basis for this new usage already were in use. Star and Ruhleder (1996, p.113), claim that “Change takes time and negotiation, and adjustment with other aspects of the systems involved. Nobody is really in charge of infrastructure “. Here, the different elements such as the mobile platform, the work practices, the organizational structures, etc., influenced each other, corroborating Ciborra et al., (2000) who emphasized that distribution of responsibility, power and governance in an organization is an important part of the installed base. Star and Ruhleder (1996, p. 4) point out their understanding of and II as a fundamentally relational concept that becomes an infrastructure in relation to organized practice.

How can generative technologies help to break with existing organisational and institutional barriers?

By thinking simply, small-scale and bottom-up and by taking the user’s needs and premises as a point of departure rather than focusing on advanced technology, an implementation process was made possible. The project became independent in choosing and shaping the new solution. We claim that the new model emerged with a larger potential for creating a new innovation path than would have been the case if it had been linked to the existing structures. Further, it illustrates how user-centered innovation can break with existing power structures through a focus on different layers in the change processes. Mobile technologies, being part of the Sami community infrastructure, allowed the project team and users to bypass organisational and institutional barriers. Based on the first of Zitttrain’s aspects of generativity, leveraging of tasks, the existing communication network could only leverage

communication only for a limited number of users and for the traditional set of communication technologies.

For all practical purposes we can regard the existing NHN as closed for innovation, and thus not particularly generative. The aspect of ease of mastery is also difficult to assess since there was no practical openness to interact with the infrastructure. While it would be available for use by the CYP specialists, it would not be available for technical modifications and tinkering. Even if it had been open for use the adaptations required would have been technically complicated and would have required assistance from technically skilled personnel. The security aspects motivated a cautious progress in these kinds of use areas. When these factors are coupled with a stronger focus on regional and national standardization and centralization of ICT initiatives, we may see that there are internal barriers to innovation initiatives. The lack of openness, flexibility and enabling factors led to an alternative development strategy. It was the fact that the IT department relinquished control and withdrew from the project that left the space wide open for the users' participation and impact on shaping the solution. The process of development led to the users' significant role in defining the solution. For instance, the choice of mobile telephones rather than computers as the basic tool enabled user participation. This again led to a technically non-complex application with intuitive usage patterns. The interplay between person and machine in the IT sector, in which the user's perceptions of the technology are emphasized, has long been a subject of discussion (Suchman, 2006). According to Zittrain (2006), there is a need for open systems to ensure the best conditions for development. Through traits of generative technology, solutions are achieved that include openness and thus cater to innovation. By mobilization of the families (patients) own resources, including the network's resources clearly contributed towards better treatment, which also is in line with arguments made by Brennan and Safran, (2003) and Ball and Lillis (2001). The selected mobile telephone technology is shown to have all traits of generativity (Zittrain, 2006). It had accessibility in the way that the teams report that all families were quickly able to use the mobile application, because everyone was already familiar with using a mobile phone. Secondly, the mobile phone technology is easy to use for families who are active in the primary industries, such as in fishing, rendering, and agriculture. It has adaptability since the mobile technology was easily modified for new purposes. The ease of use of the mobile phone technology in the project was high. There were no technical problems. All the participating families were able to use the specially designed application to fill in the schema with the points for behavior. The leverage of the mobile phone technology was limited by the centralized model of NHN. The mobile solution stands outside the existing infrastructure and has worked well during the test period. In terms of leverage, however, the solution needs to be integrated in the existing infrastructures, including NHN, if healthcare workers and their organisations want to develop and implement new tasks with this technology. The criterion of transferable, the result of skilled users' adaptations can be easily conveyed to others less-skilled.

The five characteristics of a generative technology do not, ask specific questions about the 'cultural infrastructure' and how this affects the accessibility, adaptability, ease of mastery, leveraging of a technology its transferability. This is in line with Zittrain's (2006) characteristics of generativity. Tuomi (2002) argues that by viewing the users as active participants in the innovation process rather than to regard them as passive consumers of the process, you get a different focus. Christensen and Bower point out that innovation involves changes in technology (1996). The choice to develop a separate application as support for a variant of the PMT-O method was made on the basis of the existing method's paper schema. This is in line with Church and Whitten (2009), who describe how users enable technology conducive to their own utilization. The new solution is planned to include a Sámi interface. The generativity of the mobile technology was not only affected by the invisibility of culture

in the current technology design. The effects of that invisibility continue in the new iteration of the technology design. In this, particular choices, in this case the lack of Sami language interface, may have effects that will continue to influence the generativity of the new version of the mobile technology, even if the interface now will be available in both Norwegian and Sami.

How can generative technologies help building open and enabling Information Infrastructures?

In both the technical, organizational and institutional contexts, there's a variety of stakeholders, resources and interests. One does not always have full control over what is needed for a user-centered innovation in the health sector to succeed in areas such as technology and organization, because knowledge and relations within the area often lie outside the health sector's sphere of activity. The inclusion of users through participation in projects is an innovative way to conceive of further development of services (Andersen & Jansen 2012). Miller and Morris (1999), acknowledge an appreciation of knowledge as part of the process of creating new products and processes. von Hippel (1998) introduces the term “sticky information” to describe information that is expensive to obtain, transmit and employ in another location than where it originated. Damsgaard et al. (1994), points out that technological innovations show that they must be understood as networks and are socially constructed. They must not be regarded as if they occur in homogeneous and socially stable or included in independent samples. *Path dependence and path creation* thus present different perspectives on innovation processes. The analysis below addresses the challenge of overcoming existing thinking (path dependency), and thereby trigger of new thinking (path creation). Path dependency in the present study is associated with existing ways by which to offer health services through the NHN infrastructure. By using the path creation perspective, a certain type of development was generated that represented a break with this socio-technical structure and thereby contributed to creating an alternative technical platform and a new way by which to offer health services. Based on this, path creation processes can be seen as proactive innovation. This is consistent with Garud and Karnøe (2001, p.2) who claim that:

“In our view, entrepreneurs meaningfully navigate a flow of events even as they constitute them. Rather than exist as passive observers within a stream of events, entrepreneurs are knowledgeable agents with capacity to reflect and act in ways other than those prescribed by existing social rules and taken-for-granted technological artefacts”. Henfridsson et al. (2009) points to the reciprocal nature of path creation and path dependencies that are reflected in actors’ ongoing enactment of existing structures. Use of a multi-layered perspective contributes to new understanding of user-centered innovation and may help in understanding the innovation processes leading to the development of a new technical solution, and corresponding organizational change processes in health care provision. Hanseth and Lundberg (2001), introduce “*work oriented infrastructures*”, which in this study are the strategy in user involvement by handling the installed base as socio-technical and heterogeneous. According to Hanseth (2002) an installed base is likely to be resistant to change because of the routinized and embedded social practice and technical systems. In my case, the existing installed base and the suggestion to use videoconference facilities was linked to a specific type of organization. Hanseth (2002, p.7) points out that *“When an infrastructure is changed or improved, each new feature added to it, or each new version of a component replacing an existing one, has to fit with the infrastructure as it is at that moment.* Related to this study, the innovation process reveals the different socio-technical elements in the already existing structures, which include different organizational structures, work practices, formal procedures for the employees in the health organization, people (health care workers, families etc., competences) etc.

Summary

The aim of this paper has been to give a deeper understanding of the connection between infrastructures and user-centered innovation. By examine what roles the various level of an information infrastructure play in the innovation processes, implying a complex interplay between technical, organizational and institutional factors. Theory of information infrastructures is used as a frame of reference for analysing what enables or constrains user-driven innovation processes within a complex organizational context. With concepts of path creation and generativity, this study aims at understanding the interaction between technical, organizational and institutional factors in user-centered development processes. By applying a multilayer perspective in the analysis of the innovation process, the analysis shows how various elements in the installed base can influence the innovation process in a complex organizational context. The analysis shows how an installed base either may enable or constrain the innovation processes, illustrating the interrelationship between technical solutions, the organizational and institutional, legal components, users and their uses. The study shows thus that user-centered innovation can be a rational driving force for meeting the challenges faced by organizations in the change processes, and that the strategic foundation of radically new ways by which to deliver health services can be robust.

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